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APOLLO 9 RTACF POSTMISSION REPORT

Flight Analysis Branch

MISSION PLANNING AND ANALYSIS DIVISION

MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

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PROJECT APOLLO

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By Stanley D. Holzaepfel
Flight Analysis Branch

June 13, 1969

MISSION PLANNING AND ANALYSIS DIVISION
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Approved: Charlie C. Allen
Charlie C. Allen, Chief
Flight Analysis Branch

Approved:
John P. Mayer, Chief
Mission Planning and Analysis Division

TABLES

APOLLO 9 RTACF POSTMISSION REPORT

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SUMMARY

The purpose of this document is to present a summary of the support provided by the Real-Time Auxiliary Computing Facility for the Apollo 9 mission. It does not present all of the computational capability possessed by the RTACF for support of the Apollo 9 mission, but only that which was actually requested and used. A complete list of requirements is given in references 1 through 10. A detailed description of the RTACF programs and processors is given in the Apollo 9 Flight Annex(ref. 11).

INTRODUCTION

In preparation for the Apollo 9 mission, a series of flight control simulations and inhouse simulations were supported by the RTACF. RTACF support of flight control simulations began on September 19, 1968, and ended on February 28, 1969. A total of 32 simulations were supported, in addition to 15 inhouse simulations and 24-hour support of the 241-hour Apollo 9 mission from March 3, 1969, to March 13, 1969. This document summarizes the RTACF support for both the simulations and the mission, including the manpower expended.

NOMENCLATURE

ACQ	acquisition of signal
ACR	Auxiliary Computing Room
AGOP	Apollo generalized optics processor
AGS	abort guidance system
ARS	Apollo reentry simulation
ARRS	Apollo real-time rendezvous support

CG	center of gravity
CLA	contingency landing area
CSM	command and service modules
CM	command module
DAP	digital autopilot
DPS	descent propulsion system
EVA	extravehicular activity
FDO	Flight Dynamics Officer
LGC	lunar module guidance computer
LM	lunar module
LOS	loss of signal
LOX	liquid oxygen
MPAD	Mission Planning and Analysis Division
MRS	mass properties, reaction control system, service propulsion system
PAO	Public Affairs Officer
PFAO	Postflight Auxiliary Observer
RCS	reaction control system
RTACF	Real-Time Auxiliary Computing Facility
RTCC	Real-Time Computer Complex
SC	spacecraft
SLA	spacecraft/LM adapter
SM	service module
SPAN	Solar Particle Alert Network
SSR	Flight Dynamics Staff Support room
ΔV	delta velocity

DISCUSSION

Included in this document are the following topics: (a) a description of the computations made, (b) typical RTACF support team, (c) simulations supported and conducted, (d) mission manpower summary, and (e) total Apollo 9 manpower required.

A description of the computations requested, the requestor, and number of times requested are presented in table I. A typical support team of both SSR and ACR personnel for either a simulation or for mission support is shown in table II. The number of inhouse simulations conducted and manpower expended are shown in table III; while the kind, duration, personnel, and manpower expended for flight control simulations are described in table IV. The RTACF manpower required for the Apollo 9 mission in both the SSR and ACR is presented in table V. In conclusion, a summation of the manpower for all simulations and mission support is given in table VI. Total manpower expended for the Apollo 9 simulations and mission totaled 9246 manhours of work.

TABLE I.- RTACF COMPUTATION SUMMARY

The following list presents the types of computations made by the RTACF during the Apollo 9 mission and a brief description of each. This summary does not reflect all of the requirements which were levied on the RTACF. There were some programs which were not used to a great extent because of the success of the flight (i.e., LM systems programs, etc.).

Type of computation	Times requested	Requestor
Mass properties.- Mass properties computations include the following.	66	Retrofire Officer
	10	Trajectory Support Chief
a. Weight-c.g. tables - used by the RTACF and RTCC trajectory processors to compute pitch and yaw trim angles		
b. Entry aerodynamics - used in the RTACF and RTCC entry processors		
c. DAP load		
AGOP.- AGOP computations include the following.	2	Guidance Officer
	25	Flight Plan Support
	3	Trajectory Support Chief
a. Star sighting table - computes sighting, attitude, and sextant data to view a target		
b. Landmark sighting - computes SC attitude to view a ground target		
c. Optical support table - computes IMU alinement by computing star sighting angles		
d. Antenna pointing - computes pitch and yaw angles to point specified antenna at target site		
PVT.- The PVT processor determines the amount of SM RCS propellant remaining and how much is usable.	1	CSM propulsion
ARRS.- The ARRS is a generalized rendezvous program that consists of the following.	125	Flight Dynamics Officer
	20	Trajectory Support Chief
a. General purpose maneuver processor computes impulsive maneuver at a point to achieve desired conditions	75	Rendezvous Support
	55	Maneuver Support
	10	MPAD

TABLE I.- RTACF COMPUTATION SUMMARY - Continued

Type of computation	Times requested	Requestor
b. Two-impulsive and terminal phase processor - computes two impulsive maneuvers by specifying point and final conditions c. Mission plan table processor - computes finite burn to achieve a given orbit d. Relative print routine - computes relative quantities between two vehicles e. Tracking routine - computes tracking station coverage during a given period of time		
Supercritical helium.- Supercritical helium computations are used to monitor the LM DPS supercritical helium propellant tank pressurization system.	3	LM propulsion
Lift-off REFSMMAT.- The lift-off REFSMMAT computation gives the onboard REFSMMAT used until the IMU is realined in orbit.	1	Trajectory Support Chief
Checkout monitor.- The checkout monitor is a table that displays orbital parameters at a specified time.	47	Trajectory Support Chief a. NORAD b. Smithsonian c. Satellite sighting
PFAO.- The PFAO computation consists of various trajectory parameters used for real-time reports to NASA Headquarters and postflight reports.	48	Postflight personnel
PAO.- The PAO computation consists of data for SC signting from various cities, press releases, and news conferences.	7	Public Affairs Office
FDO orbit digitals.- The FDO orbit digitals provide orbital parameters based on current orbit or projected orbit.	7	Trajectory Support Chief

TABLE I.- RTACF COMPUTATION SUMMARY - Continued

Type of computation	Times requested	Requestor
Sun look angles.- The sun look angles computation provides the angles the sun vector makes with respect to the SC coordinate system	20	Flight plan support personnel
Navigation update.- The navigation update computation provides a state vector in the correct units to update the S-IVB, CSM, LGC, or AGS computers.	5 2	Guidance officer Trajectory Support Chief
Groundtracks and plot tape.- The groundtracks and plot tape provide a time history of SC position in either computer output or X-Y plot tape.	30	Trajectory Support Chief a. Earth Resources Division b. Recovery c. Operations Applications Office
Maneuver evaluation.- The maneuver evaluation computes an equivalent maneuver from a preburn and postburn vector.	2 4	Flight Dynamics Officer Trajectory Support Chief
CSM MRS.- The CSM MRS computes a complete RCS propellant budget based on the current flight plan.	10	CSM propulsion
Work schedule processor.- The work schedule processor computations include the following.	2 30	Trajectory Support Chief Flight plan support
a. Radar ACQ and LOS data	6	Retrofire Officer
b. SC daylight/darkness data	10	Track
c. Moon rise/moon set data		
d. Orbital events		
e. Landmark sighting		
f. Star ACQ and LOS data		
g. Closest approach data		
h. Pointing data		

TABLE I.- RTACF COMPUTATION SUMMARY - Continued

Type of computation	Times requested	Requestor
Entry groundtracks.- The entry groundtrack computation provides a time history of SC position during entry.	11	Trajectory Support Chief a. Retrofire Officer b. Recovery c. Track
Maneuver confirmation.- The maneuver confirmation computes actual maneuvers by application of ΔV residuals from a particular maneuver to the nominal ΔV targets.	4 1 2	Trajectory Support Chief Flight Dynamics Officer Retrofire Officer
Radiation dosage.- The radiation dosage processor provides a time history of radiation dose and dose rate for both CSM and LM cabins.	12	Radiation
Docking alinement.- The docking alinement computes REFSMMAT or attitude of CSM or LM in docked configuration.	3	Guidance Officer
LM and CSM SEENA.- The LM and CSM SEENA programs compute electrical capability, energy drain, and energy remaining for any configuration.	2 1	LM electrical power systems CSM electrical power systems
CM and SM pointing.- The CM and SM pointing data provide time time history data from radar sites to track the entering vehicle.	17 6	Track MPAD
EVA attitude control.- The EVA attitude control provides REFSMMAT and gimbal angles for optimum lighting for extravehicular activity.	1	Flight plan support
K-factor.- The K-factor processor determines the atmospheric density multiplier for optimum near-earth orbital propagation.	18 5 2	Flight Dynamics Officer Trajectory Support Chief MPAD

TABLE I.- RTACF COMPUTATION SUMMARY - Concluded

Type of computation	Times requested	Requestor
Lifetime.- The lifetime processor determines the orbital lifetime of a particular vehicle.	5 3	MPAD Flight Dynamics Officer
Command load.- The command load provides conversions of engineering units with the proper scaling factor to uplink octal units.	4	Trajectory Support Chief
Sun impingement processor.- The sun impingement processor determines gimbal angles to point a specific location on the SC toward the sun.	1	Guidance Officer
SPAN.- The SPAN processor determines the radiation intensity that results from solar flares.	1	Radiation
Wind data.- The wind data processor predicts mode I impact points based on the current wind profile at launch pad.	19	Recovery
Entry.- The entry computations include the following. a. CLA/ARS - determination of deorbit burn or entry or both to hit a specified target b. Apogee - SM RCS burn about apogee and resultant impact point c. Hybrid - combination of an SM RCS and a CM RCS burn to hit a target. d. No SLA separation - a deorbit that uses an S-IVB LOX dump and CM RCS burn e. Block data - a set of deorbit times and events sent to the crew for emergency use	173 25 50	Retrofire Officer Deorbit support Trajectory Support Chief

TABLE II.- TYPICAL RTACF SUPPORT TEAM

[SIMULATION OR MISSION]

SSR staff	
Trajectory Support Chief	1
Assistant Trajectory Support Chief	1
Specialist (maneuver, rendezvous, deorbit)	2
Nontechnical support	1
ACR staff	
ACR Chief	1
Trajectory Analyst	3
Program Consultant	2
Nontechnical support	4
Total	15

TABLE III.- RTACF INHOUSE SIMULATIONS CONDUCTED

Number of simulations	15
Total simulation hours	69
Average technical personnel	10
Average nontechnical personnel	4
Total manpower, hr	966

TABLE IV.- RTACF FLIGHT CONTROL SIMULATION

PARTICIPATION AND MANPOWER EXPENDED

(a) Participation

Type	Date month-day	Duration, hr	SSR	ACR
ME 103	9-19-68	13	2	9
ME 103	9-20-68	12	2	12
ME 103	9-21-68	12	2	9
FMES	11-1-68	10.5	3	9
FMES	11-2-68	11	3	10
TD&E	1-8-69	6	3	7
REND	1-9-69	12	4	12
REND	1-10-69	10.5	3	13
REND	1-11-69	10.5	4	12
SPS	1-13-69	15.5	4	10
REND	1-14-69	10.5	3	13
ENTRY	1-15-69	11.5	6	9
REND	1-24-69	10.5	3	10
LM EVAL	1-27-69	12	3	3
DPS-1 SPS-5	1-28-69	10.5	4	8
REENTRY	1-29-69	12.5	6	9
DPS-1	1-30-69	10.5	5	8
REND	2-3-69	10.5	5	11
S-N-S	2-4-69	10	3	8

TABLE IV.- RTACF FLIGHT CONTROL SIMULATION

PARTICIPATION AND MANPOWER EXPENDED - Continued

(a) Participation

Type	Date month-day	Duration, hr.	SSR	ACR
DPS-1	2-6-69	11	4	9
TD&E	2-7-69	8	3	7
EVA	2-8-69	4	2	3
REND	2-11-69	12	3	12
REND	2-12-69	11	4	10
DPS-1	2-13-69	10	4	8
REND	2-14-69	10.5	3	10
EVA	2-15-69	6	2	3
L.A.	2-20-69	6.5	2	8
REND	2-21-69	12	5	12
N.S.	2-22-69	4.5	3	12
ENTRY	2-24-69	12	5	10
DPS-1 TD&E	2-28-69	12	4	10

TABLE IV.- RTACF FLIGHT CONTROL SIMULATION

PARTICIPATION AND MANPOWER EXPENDED - Concluded

(b) Manpower

Summary	SSR	ACR
Number of simulations	32	32
Average length, hr	10.2	10.2
Average technical personnel per simulation	4	5
Average nontechnical personnel per simulation	1	4
Manpower expended for simulations, man hours	2938	1632
Total manpower, man hours	4570	

TABLE V.- RTACF MANPOWER REQUIRED FOR MISSION SUPPORT

Position	Number of personnel	Hours present	Total manhours
(a) SSR staff			
Trajectory Support Chief, FAB	1	246	246
Asst. Trajectory Support Chief, FAB	1	246	246
Maneuver specialist, OMAB	2	137	274
Deorbit specialist, LAB	2	84	168
Rendezvous specialist, OMAB	2	35	70
Nontechnical personnel, ITT	1	246	246
(b) ACR staff			
ACR Chief, TRW	1	246	246
Trajectory analyst, TRW and MPAD	3	246	738
Program consultant, TRW and LEC	2	246	492
Nontechnical support, ITT and LEC	4	246	984
Total			3710

TABLE VI.- TOTAL RTACF MANPOWER REQUIRED FOR APOLLO 9

SUPPORT (ACR AND SSR)

Total inhouse simulation support (ACR), manhours	966
Total flight control simulation support (ACR), manhours	1632
Total flight control simulation support (SSR), manhours	2938
Total mission support for ACR, manhours	2460
Total mission support for SSR, manhours	1250
Total manpower expended, manhours	9246

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